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PERFORMANCE AND EMISSION CHARACTERISTICS OF PALM OIL AS AN ALTERNATE FUEL IN DIESEL ENGINE

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ABSTRACT

The main objective of this project is to analyze the performance and emission characteristics of palm oil as an alternative fuel in diesel engine. This project is carried out to overcome the energy deficiency in the present scenario. In this modern world pollution is the major problem in all the countries. This is due to non renewable energy resources usage as well as fuel blending ratio which is used in diesel engine. Now a day's diesel is mixed with other oils and used as a alternative fuel in domestic applications. The pollution and energy deficiency is accepted by all the engineers in the world and many numbers of researches going on in this field. This is one of the researches to estimate emission characteristics in the diesel engine in both emission and performance. There are many numbers of alternative fuels available in this world among this Trans-esterification vegetable oil is most efficient and economical source. The following ratios of palm oil and diesel are taken as a blending ratio 25/75, 50/50 and 100% by volume. Brake specific fuel consumption, brake thermal efficiency, volumetric efficiency is calculated at given injection pressure of 200 kg/cm^2. The performance parameters and emission characters are compared conventional engine. This project concludes that palm oil 25/75 at injection pressure of 200 kg/cm2, in comparison with 50/50 blends gives better results.

KEYWORDS: Palm Oil, Diesel Engine, Performance, Blend Ratio & Emission

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Original Article

INTRODUCTION

Diesel is used as fuel and it is one of the most important sources for power generation and transportation in day to day life. It is widely used in many applications such as power- generation, agricultural applications etc. But pollution is the major problem in conventional fuel and the demand is also more. To overcome that, vegetable oils like palm oil and neem oil are considered as best alternates. There are many methods are available to reduce viscosity but heating method is most efficient and economical. If the oil is heated with gradual temperature automatically it is leads to reduce the viscosity of oil. This low viscosity helps to increase the performance of the diesel engine. Normally diesel fuel injection system is manufactured with close fittings to reduce heat emission and also it has plunger and barrel assembly. Due to this assembly it can take high amount of fuel with higher temperature but diesel engine can run ambient temperature of fuel. When the vegetable oil is heated with required temperature then it is changing as high viscosity oil into low viscosity oil and its impact of damage is low in the injection system.

PALM OIL

Palm oil is derived from the palm trees and has high beta carotene content due to which they are red in color. It is being referred as "Crude Palm Oil" in the initial stages. After the purification process in the refineries, then resultant oil's quality is categorized to bio diesel fuel. This is used as edible oil in the African countries. It is

highly saturated oil with fatty acids, esterifies with glycerol. Palm oil is an important source of calories and if it is used it reduces the blood cholesterol level when compared to other edible oils. In terms of food as well as fuel palm oil is the best in the market. The bio waste that is being produced from the refining process of palm oil can be used for making oil shells and other bio fuels.

Table 1: Properties of Diesel, Cotton Seed Oil, Palm Oil and Neem Oil

Properties/Oils	Diesel	Palm Oil
Density(Kg/m3)	815	864
Viscosity, CSt	4.8	41.2
Calorific Value(MJ/Kg)	45.52	37.2

It is very difficult to modify the engine when compared with modifying the fuel so, in this research fuel is modified with desire blending ratio. This technique is very much helpful to generate the power easily compared to other methods. The preparation of blends also easier and it is taking less time and it is very easy to start the engine by using diesel fuel. In this method ignition accelerators technique has been used in the four stroke diesel engine without doing any kind of modifications to the existing Compression Ignition engine. Hexyl nitrate, Iso-amyl nitrate, Cyclohexyl nitrate, ethylene glycol, alcolita are identified as good ignition improving additives in diesel engines. They produce good results by improving the cetane number of alcohols and make them best suitable for operation in Compression Ignition engine. The advantage of these additives is that no engine modification is necessary to use alcohols. Additionally, Palm Oil Biodiesel can be blended with petroleum diesel.

EXPERIMENTAL SET-UP

The experimental setup model consists of a single-cylinder, four-stroke, natural aspirated, direct injection diesel engine and it is directly connected to water brake dynamometer for loading and unloading of the engine. Experiments are conducted and it is based on pure diesel blends of palm oil which is already prepared one. The signals are produced from the engine is interfaced to a computer through an engine indicator to record pressure-crank angle diagram. Arrangement is also made for calculating air and fuel flow as well as temperatures and load indications. Finally comparison of the engine performance, emissions and combustion with Diesel alone and blends of palm oil were done. The details of engine specifications are presented in Table 2.

Table 2: Engine Specifications

Make	Kirloskar Oil Engines Ltd.India
Type	Single Cylinder DI, NA CI Engine
Rated Output	3.68 kW
Engine Speed	1500 rpm
Injection Timing	26.40BTDC
Loading Device	Hydraulic dynamometer
Stroke	110 mm
Compression Ratio	16.5:1
Bore	80 mm

The experiment is done at constant speed of 1500 rpm with the temperature of engine jacket cooling water between 50degC – 60degC.

- To reach the steady state condition, engine is made to run for about 30 minutes at a speed of 1500 rpm.
- At no load condition, once steady state condition is reached, the time for 10cc fuel consumption and for one m^3 of air consumption is noted down.
- The loads is being varied till 3.3kgs and the experiment is repeated. And the step no 2 is repeated for the time calculation.
- Taking fuel oils like 25P75D and 50P50D the experiments are repeated as mentioned above.

At various load condition, the performance of Direct Injection diesel engine with various blends of palm oil with diesel, cottonseed oil with diesel, Neem oil with diesel has been done and compared the performance, combustion characteristics of the above oils with those of diesel, to find which oil is best suitable for DI diesel engines and Heat balance tests on exhaust gas analysis is done to determine good performance.

FUEL PREPARATION

The main research focused in earlier days is to rectify the vegetable oil viscosity which is higher in the existing natural edible oils. There are many methods available in the universe to reduce viscosity of oil. In this work, blending of the vegetable oils with desirable ratio with diesel is formed to reduce the viscosity of oils.

BLEND PREPARATION

The fuels chosen for testing the engine to find the performance of the engine is palm oil which is having viscosity of 41.2 cSt.

The following blends of palm oil and diesel are prepared to conduct the experiment

Blend ratio 1: 25% palm oil with 75% diesel (25P75D)

Blend ratio 2: 50% palm oil with 50% diesel (50P50D)

The above proportions blends are used in emulsifier. This experiment set up is attached with 500mm capacity of measuring flask which is used to measure volume. Supplied oils are measured with the help of flask with respect to blending ratio then it is allowed in to the emulsifier. When the palm oil and diesel mixed with 25% and 75% it is taking least time for complete mixing. Others proportion of blends taking more time for complete mixing.

Figure 3.1: Emulsifier for Mixing of Fuel

RESULTS AND DISCUSSIONS

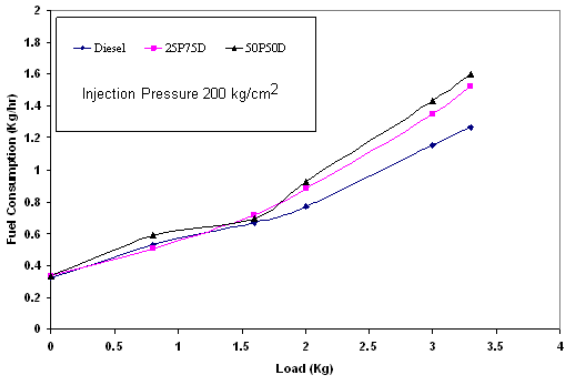

Figure1: Comparison of Fuel Consumption Vs Load

The fuel consumption is taken in y axis and load variation taken in x axis with the applied pressure of 200kg/cm^2 and the final results are indicated in figure.1.This plotted graph clearly states that fuel consumption is more in palm oil and diesel blends compared to an normal diesel fuel. The complete atomization is possible only when the oil droplets are supplied with lower viscosity. If viscosity is higher than effective diameter of combustion chamber is also higher. So result shows that fuel consumption is high when compared with normal diesel fuel.

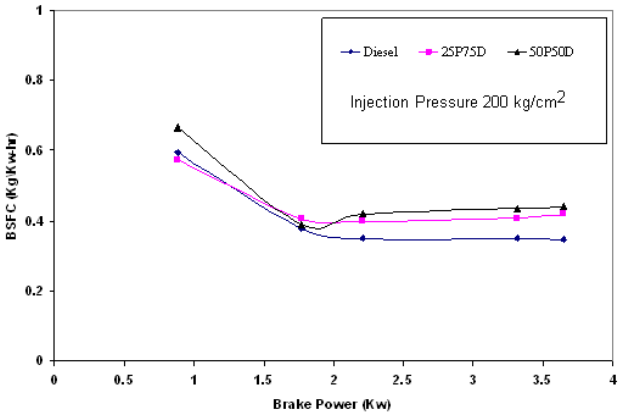

Figure 4.2: Comparison of Brake Specific Fuel Consumption Vs Brake Power

The brake specific fuel consumption is taken in y axis and brake power is taken in x axis with the applied pressure of 200 kg/cm^2 and the final results are indicated in figure.2. This plotted graph clearly states that brake specific fuel consumption is more in palm oil and diesel blends when compared to a normal diesel fuel. During complete burning process the evaporation rate of fuel is more this is due to high calorific value of the fuel. But in this process the calorific value of palm oil and diesel blends are very less when compared with normal diesel fuel. So results show that higher brake specific fuel consumption is due to slower evaporation.

The volumetric efficiency is taken in y axis and applied loads are taken in x axis with the applied pressure of 200 kg/cm^2 is shown in figure 3.this graphical representation clearly explains when the load is increased, the volumetric efficiency is decreased and volumetric efficiency increases when the load is decreased. Here also volumetric efficiency of the palm oil blend is very less when compared with normal diesel fuel. So it will directly affect the overall efficiency of the engine.

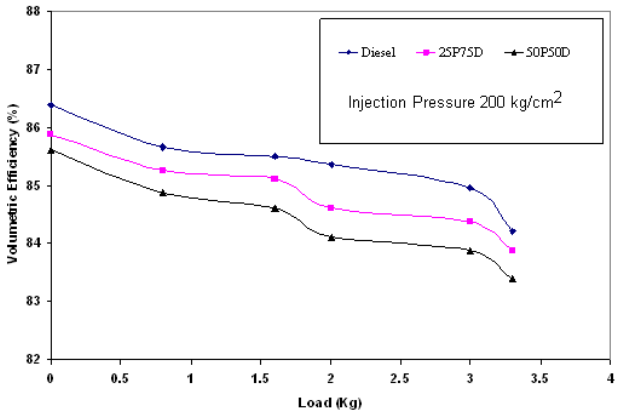

Figure 4 3: Comparison Volumetric Efficiency vs Load

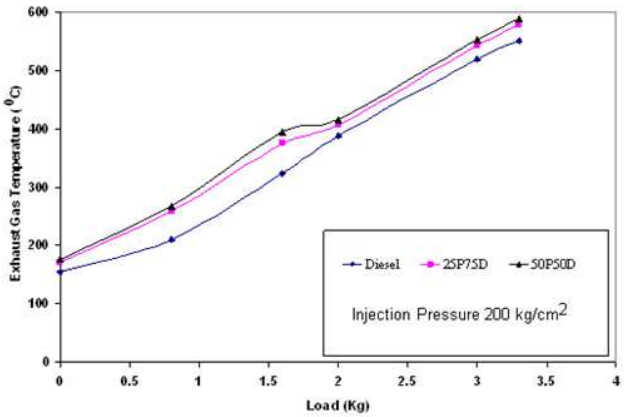

Figure 4.4: Comparison of Exhaust Gas Temperature vs. Load

The exhaust gas temperature is taken in y axis and applied loads are taken in x axis with the applied pressure of 200 kg/cm2 is shown in figure.4. Emissions of exhaust gas are high in the palm oil blend when compared with in normal existing diesel fuel. This is due to improper burning of fuel in combustion chamber but in the normal diesel engine emissions are less because of complete burning.

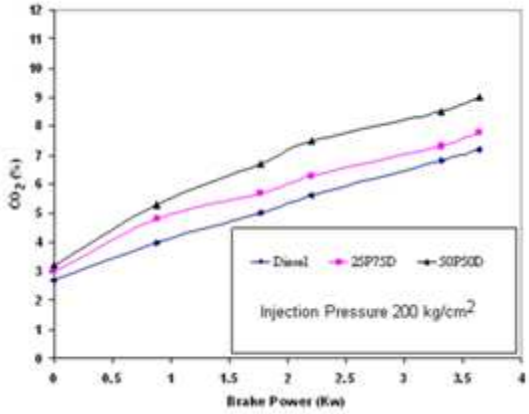

Figure 4.5: Comparison of CO2 Emission vs Brake Power

In Figure.5 CO_2 percentage is taken in y axis and brake power is taken in x axis.CO_2 emissions are higher in 50% of palm oil blend and CO_2 emissions are less in 25% of palm oil blend with the applied pressure of 200kg/cm^2 .the

difference between 25% blend and 50% blend is around 8 to 10.

In Figure.6 CO percentage is taken in y axis and brake power is taken in x axis. CO emissions are higher in 50% of palm oil blend and CO emissions are less in 25% of palm oil blend with the applied pressure of 200kg/cm^2 .the difference between 25% blend and 50% blend is around 7 to 11.

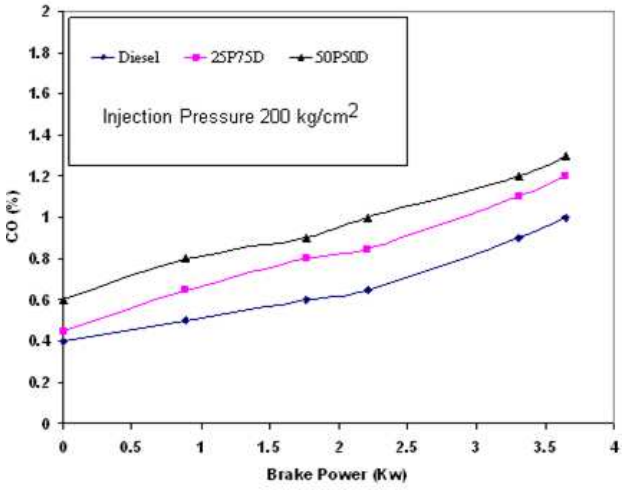

Figure4 6: Comparison of CO Emission Vs Brake Power

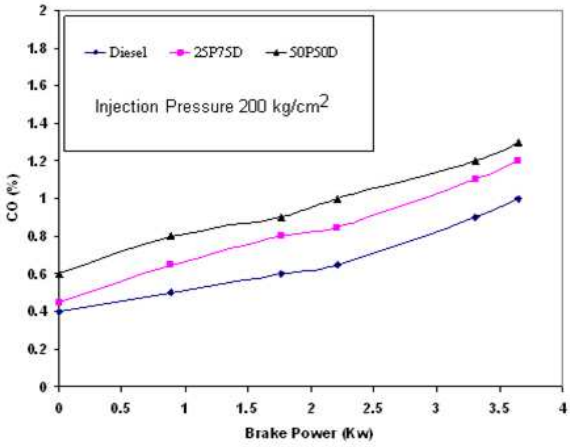

Figure 4 7: Comparison of HC Emission Vs Brake Power

In Figure.7 hydro carbon emission is taken in y axis and brake power is taken in x axis. the result obtained is with the applied pressure of 200 kg/cm2 is palm oil with 50% blend, has more hydro carbons and palm oil with 25% blend has less hydro carbon contents.

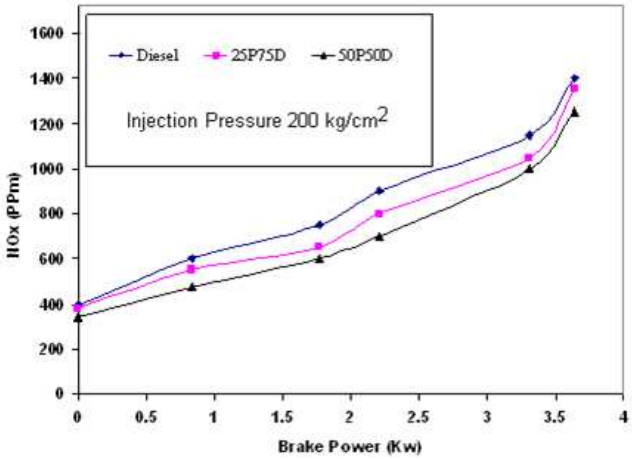

Figure 4 8: Comparison of NOX Emission Vs Brake Power

In Figure.8, nitrogen oxides is taken in y axis and brake power is taken in x axis.This plotted graph clearly shows that 25% of palm oil blend has less NO_X emissions and 50% palm oil blend has more NO_X emissions with the applied pressure of 200 kg/cm^2

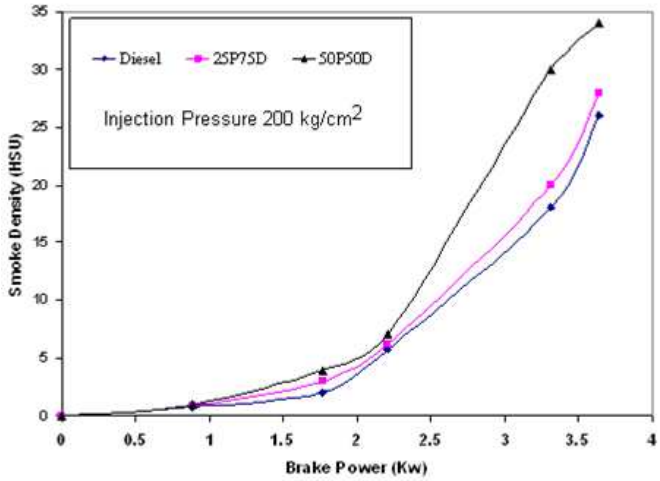

Figure 4 9: Comparison of Smoke Level Vs Brake Power

In Figure.9 smoke emission is taken in y axis and brake power is taken in x axis, for palm oil with diesel blends with applied pressure of 200kg/cm^2 .This blended ratio has more smoke emission than normal diesel fuel. 25% blend of the palm oil smoke level is well comparable with diesel.

Finally, all parameters are computed with the applied pressure of 200kg/cm^2 with various loads and no load conditions.

CONCLUSIONS

This Project work is performed in single cylinder four stroke diesel engines and piston, in the shape of hemispherical bowl with some various additives, are used with fuel for accelerating purpose. This work is mainly focused, to analyze the performance capacity of diesel engine, with various blends of palm oil with diesel. This study has been chosen 25P75D and 50P50D blending ratio of palm oil and diesel fuel. These ratios are considered as substitute for

existing conventional diesel engine with the specification of single cylinder with direct fuel injection system integrated with naturally aspirated diesel engine. The various number of tests are conducted by applying various fuel blends in the diesel engine running at the speed of 1500 rpm and also inspected various load conditions and no load conditions. At each test the parameters like fuel consumption, exhaust emissions, brake thermal efficiency are recorded. The final output of brake thermal efficiency for 25P75D at full load is 0.419167 Kg/Kw-hr to injection pressures of 200 kg/cm^2. The brake specific fuel consumption values for 50P50D at full load are 0.43926752Kg/Kw-hr. The brake thermal efficiency values for 25P75D at full load are 20.19% to injection pressures of 200 kg/cm2, the brake thermal efficiency values for 50P50D at full load are 19.77%.

REFERENCES

1. *Heywood JB. Internal combustion engine fundamentals. In: Duffy A, Morriss JM, editors. New York: McGraw-Hill, Inc.; 1988.*
2. *Ekrem Buyukkaya Eect of biodiesel on a DI diesel engine performance, emission and combustion characteristics, Fuel 89, pp. 3099- 310, 2010.*
3. *S. Jindal, B.P. Nandwana, N.S. Rathore, Experimental investigation of the effect of compression ratio and injection pressure in a direct injection diesel engine running on Jatropha, Applied Thermal Engineering 30,pp. 442448, 2010.*
4. *Labeckas G, Slavinskas S. The effect of rapeseed oil on direct injection Diesel engine performance and exhaust emissions. Energy Convers Manage 2006;47:1954–67.*
5. *Di Y, Cheung CS, Huang ZH. Experimental investigation on regulated and unregulated emissions of a diesel engine fueled with ultra-low sulfur diesel fuel blended with biodiesel from waste cooking oil. Sci Total Environ 2009;407:835–46.*
6. *Muralidharan K, Vasudevan D. Performance, emission and combustion characteristics of a variable compression ratio engine using waste cooking oil and diesel blends. Appl Energy 2011;88:3959–68. Performance And Emission Characteristics Of C.I. Engine Fuelled With Diesel-Biodiesel Blends www.iosrjournals.org 121 | Page*
7. *Qi DH, Chen H, Geng LM, Bian YZ. Effect of diethyl ether and ethanol additives on the combustion and emission characteristics of biodiesel-diesel blended fuel engine. Renew Energy 2011;36:1252–8.*